LIFD

Leeds Institute for Fluid Dynamics

# 5th Celebration Event

# Programme & Abstract Booklet

# Welcome

**“We are pleased to welcome colleagues from across the UK Fluids Community to the LIFD 5th birthday event. Fluid dynamics continues to be a major UK industrial and research strength, and is critical to many applications. LIFD was established to ensure that not only Leeds, but the UK continues to be at the forefront of this exciting and critical discipline” LIFD Director, Prof Steve Tobias**

The Leeds Institute for Fluid Dynamics (LIFD) is a cross-disciplinary research institute bringing together the expertise of over 300 members of staff, postdoctoral researchers and PhD students with teaching and research interests in fluid dynamics. The institute was established in 2018, and builds on a 50 year interdisciplinary track record of research in fluids. We provide a hub to facilitate world-leading research and education in fluid dynamics and to bring interdisciplinary perspectives to complex flow challenges.

Our objectives focus on four key areas:

- International standing: To be a world leading centre for Fluid Dynamics, and to continue to build the UK reputation for international excellence in fluid dynamics;
- Collaborative research capabilities: To enable excellence through collaboration, facilities and support to researchers;
- Strategic partnerships: To build and maintain partnerships worldwide with end-users, academia, funders and alumni;
- Excellence in training: To support cross-disciplinary postgraduate level training through MSc, PhD and short courses.

Visit our brochure for more information.

# Programme

## Day one – 25th January 2024

| Time | Activity |
|---|---|
| 12.00-13.30 | Lunch and registration |
| 13.30-13.45 | Welcome - Prof Nick Plant, DVC for Research and Innovation, University of Leeds<br><br>*Chair: Prof Cath Noakes* |
| 13.45-14.30 | Keynote talk - Professor Stephen Belcher, Chief Scientist, UK Met Office<br>"The fluid dynamics of weather and climate forecasting"<br><br>*Chair: Prof Cath Noakes* |
| 14.30-15.15 | Dr Sepideh Khodaparast, School of Mechanical Engineering, University of Leeds<br>"Fluid-driven approaches for precision surface patterning"<br><br>Maria Taccari, School of Civil Engineering and School of Computing, University of Leeds<br>"Deep Learning for Groundwater Modelling"<br><br>*Chair: Prof Cath Noakes* |
| 15.15-15.45 | Break and posters |
| 15.45-16.15 | Dr Andy Lawrence, Head of Engineering, EPSRC<br>"The importance of UK Fluids to UKRI"<br><br>*Chair: Prof Chris Davies* |
| 16.15-16.45 | Professor Steve Tobias, Professor of Applied Mathematics, LIFD Director<br>"LIFD – 5 years of fluids and looking to the future"<br><br>*Chair: Prof Chris Davies* |
| 17.00-18.00 | Drinks reception, canapés and posters |
| 18.00-18.45 | Keynote talk and Public Lecture - Sir Steven Cowley, Director, Princeton Plasma Physics Laboratory |

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|---|---|
| | "Stability and Meta-stability: a challenge for fusion"<br><br>*Chair: Prof Dame Jane Francis* |

# Day two – 26th January 2024

| Time | Activity |
|---|---|
| 09.00-09.30 | Arrival |
| 09.30-10.15 | Keynote talk - Professor Dame Ann Dowling,<br>Deputy Vice-Chancellor and Emeritus Professor of Mechanical Engineering, University of Cambridge<br>"The relevance of fluids research to industry and to society"<br><br>*Chair: Prof Peter Jimack* |
| 10.15-11.15 | Women in Fluids discussion panel - Guneet Hawley (Arup), Dr Claudia Casto Facetti (AirRated), Dr Carolanne Vouriot (University of Sheffield), Dr Talia Tokyay Sinha (Mott MacDonald), Prof Dame Jane Francis (British Antarctic Survey and University of Leeds)<br><br>Discussion topics: why fluid dynamics?; inspiration; barriers/challenges and how to overcome them; how does fluids need to change?; how do we get more women into fluids?<br><br>*Chair: Prof Peter Jimack* |
| 11.15-11.45 | Break |
| 11.45-12.30 | Maths World UK CEO Katie Chicot and LIFD outreach ambassadors Yatin Darbar and Ciara Higham, University of Leeds<br>"Fluids outreach and Engagement– examples and opportunities"<br><br>*Chair: Dr Sepideh Khodaparast* |
| 12.30-13.15 | Dr Calum Skene, School of Mathematics, University of Leeds<br>"Adjoints and their uses in fluid dynamics"<br><br>Dr Thomas Sykes, University of Oxford<br>"Droplet impact on liquid pools"<br><br>*Chair: Dr Sepideh Khodaparast* |
| 13.15-14.00 | Lunch and Outreach Demos |
| 14.00-14.45 | Keynote talk- Professor Cath Noakes, |

| | |
|---|---|
| | Professor of Environmental Engineering for Buildings, University of Leeds<br>"The fluid dynamics of infections - from science to policy"<br><br>*Chair: Prof Steve Tobias* |
| 14:45-15:00 | Close- Professor Steve Tobias, LIFD Director. |

**Please register to attend to receive venue details**

# Invited Speakers

## Professor Stephen Belcher, Chief Scientist, UK Met Office


**Abstract Title**

The fluid dynamics of weather and climate forecasting


**Abstract**

Weather and climate forecasting are demanding computational fluid dynamics (CFD) problems - complex, high-resolution, coupled models that are being tested through repeatedly assimilating new observations to produce forecasts within a narrow operational window, every day of the year. Similarly, climate predictions, for example UKCP18 (the UK Climate Predictions 2018), require vast computers to run the weather models into future climate scenarios to provide advice to citizens, private sector and Governments.

In this talk I will describe the process of making a weather and climate forecast, and how consistent investment in CFD has led to a consistent improvement in predictive capability. We shall also explore some of the remaining challenges, such as the representation of the moist convection that yields powerful tropical thunderstorms, and then scales up to affecting our weather in the mid latitudes, or the 2d turbulence in the ocean that is so important for the overall ocean circulation, and then the carbon cycle, so important for climate. Finally, I shall introduce some very recent results from AI deep learning emulators of weather models, which point to a major disruption in how operational centres produce weather forecasts, and may well disrupt the whole fluid dynamics endeavour!


**Speaker Biography**

Stephen Belcher is Chief of Science and Technology at the UK Met Office with responsibility for leading the research and development of the Met Office's work on weather and climate. The Met Office team of more than 800 research scientists and technologists has earned a world-wide reputation for excellence in weather and climate science and the translation of this science into weather and climate services for daily weather forecasts, emergency response (for example to volcanic eruptions), and into climate change mitigation and adaptation.

As Chief of Science and Technology, Stephen has overall responsibility for the leadership and management of the Met Office's scientific and technical programmes, by providing strategic direction, ensuring high quality delivery and nurturing scientific and technological excellence. He represents the Met Office on science and research technology to UK Government, ensuring that the Met Office science programme fits properly into the wider UK environmental science landscape. Stephen is also a member of the UK Government Chief Scientific Advisor network led by Professor Dame Angela McLean.

Dr Sepideh Khodaparast, University Academic Fellow, University of Leeds

**Abstract Title**

Fluid-driven approaches for precision surface patterning

**Abstract**

Micro/nano-patterned surfaces have found increasing applications in various emerging technologies thanks to their supreme functionalities related to wetting, self-cleaning, adhesion, acoustics and interactions with biological entities. Developing practical techniques to fabricate larger areas of such surfaces in a well-controlled and cost-effective manner, however, remains challenging. After a brief introduction to biomimetic engineering, this presentation will showcase examples of how natural inspirations can guide us to achieve functional design and sustainable manufacturing of scalable structured surfaces. I will discuss spontaneous yet predictable interfacial architectures generated through fluid-based methods that exploit thermodynamic phase change processes, namely condensation and crystallisation. Finally, I will demonstrate examples of the interfacial functionalities emerging from such surface structures.

**Speaker Biography**

Sepideh Khodaparast joined University of Leeds as a University Academic Fellow in 2019. Her research is focused on diverse fundamental and applied interfacial problems that involve fluid, surface, and colloidal interactions. She obtained her MSc and PhD degrees in Mechanical Engineering from Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland. In 2015, she received a Swiss National Science Foundation fellowship to join the Complex Fluids Group at Princeton University as a postdoctoral fellow. Prior to joining University of Leeds, she was a research associate at the Department of Chemical Engineering, Imperial College London.

## Maria Taccari, PhD student, University of Leeds

**Abstract Title**

Deep Learning for Groundwater Modelling

**Abstract**

This talk by Maria Luisa Taccari, a final-year PhD candidate from the University of Leeds, delves into the development of deep learning surrogate models in groundwater flow simulation. Surrogate models serve as efficient approximations of complex numerical groundwater models, like MODFLOW, which are traditionally crucial for water resource management but come with high computational demands. Through her research, Maria Luisa has illustrated that deep learning surrogate models, encompassing standard computer vision models, transformers, and neural operators, can substantially reduce computational demands. These data-driven methods have shown the potential to mimic the capabilities of numerical techniques accurately and efficiently. Finally, the talk also touches upon the application of these models with real-world data, which present unique challenges such as accounting for time-dependent problems, sparse data, and true-world variability.

**Speaker Biography**

Maria Luisa Taccari is currently pursuing her PhD at the University of Leeds, under the guidance of Dr. Xiaohui Chen from the School of Civil Engineering, Professor Peter Jimack from the School of Computing and Dr. He Wang from the Department of Computer Science at University College London. Her research focuses on the development of deep learning surrogate models in groundwater flow simulation. Maria Luisa holds a BSc from the University of Padova and an MSc from TU Delft University, both in Civil Engineering and awarded cum laude. Prior to her PhD, Maria Luisa had five years of industry experience working at the Dutch research institute, Deltares.

## Dr Andy Lawrence, Head of Engineering, EPSRC

**Abstract Title**

The importance of UK fluids research and innovation

**Abstract**

Fluid dynamics is of vital importance the UK economy and cuts across many of the interests of UKRI. This presentation will highlight some of the key areas where research and innovation supported by UKRI has made a significant impact for the UK and will explore the future potential for greater interdisciplinary working to progress new innovations in fluid dynamics to tackle multiple major societal challenges across industrial, biomedical, astrophysical and environmental sectors.

**Speaker Biography**

Andy Lawrence is the Head of Engineering at the Engineering and Physical Sciences Research Council (EPSRC) as part of UKRI, and has been responsible for strategy and delivery of EPSRC's investment in engineering research across UK academia since September 2016. The theme covers a diverse portfolio of civil, mechanical, chemical and materials engineering disciplines, in addition to enabling technologies and systems, such as robotics, and parts of biomedical and electrical engineering. He has led numerous impactful schemes such as the Engineering Engagement Champions and the National Fellowships in Fluid Dynamics, and most recently initiated the Tomorrow's Engineering Research Challenges activity.

Andy joined EPSRC in 2007 and has held roles in EPSRC's Strategy and Planning team providing support to the Executive Leadership team and in senior portfolio manager positions in the Manufacturing the Future and ICT themes. Prior to his career at EPSRC, Andy gained a PhD in atmospheric dynamics from the University of Cambridge and held academic research posts at the British Antarctic Survey, Massachusetts Institute of Technology and the European Centre for Medium-Range Weather Forecasts.

## Professor Steve Tobias, Professor of Applied Mathematics, LIFD Director, University of Leeds

**Talk Title**

LIFD – 5 years of fluids and looking to the future

**Speaker Biography**

Steve Tobias is Professor of Applied Mathematics at the University of Leeds and Director of the Leeds Institute for Fluid Dynamics. His research focuses on turbulent flows in geophysics and astrophysics and their interaction with magnetic fields in planets and stars. His research utilises a range of techniques from the very mathematical, through high-performance computing to data-driven fluids and machine learning. He received his PhD in Mathematics from Cambridge University in 1995 and then took up research fellowships at the University of Colorado in Boulder and Trinity College, Cambridge, before moving to Leeds in 2000. He was recently elected as Rothschild Visiting Professor at the Isaac Newton Institute in Cambridge (2022) and as a Fellow of the American Physical Society (2024).

Sir Stephen Cowley, Director of the Princeton Plasma Physics Laboratory

**Abstract Title**

Stability and Meta-stability: a challenge for fusion

**Abstract**

Instability limits the pressure and the current in fusion plasmas. These limits can be *soft,* where the instability effectively prevents the plasma exceeding the limit but does not disrupt explosively. More problematically, limits can be *hard,* where the plasma releases considerable amounts of energy explosively to bring it well below the stability limit. I will demonstrate that pressure driven modes can and do exhibit both kinds of behavior. The consequences for fusion will be discussed.

**Speaker Biography**

Steven Cowley, a theoretical physicist with a focus on fusion energy, became the seventh Director of the Princeton Plasma Physics Laboratory in 2018, and a Princeton professor of astrophysical sciences. He has held positions on both sides of the Atlantic including: President of Corpus Christi College and professor of physics at the University of Oxford and chief executive officer of the United Kingdom Atomic Energy Authority (UKAEA).

## Professor Dame Ann P Dowling, Deputy Vice-Chancellor and Emeritus Professor of Mechanical Engineering, University of Cambridge

**Abstract Title**

The relevance of fluids research to industry and to society

**Abstract**

As emphasised in the excellent report *Our Fluid Nation: The Impact of Fluid Dynamics in the UK*[1] fluids is a multidisciplinary field and an important enabling technology for many companies and across many application areas. This talk will aim to reinforce that message by reviewing a selection of research projects in fluids which demonstrate its relevance to a wide range of industries and to addressing societal challenges.

Reference

[1] Juniper, M, Noakes, C, Tobias, S, Savy, C and Lincoln, J. *Our Fluid Nation: The Impact of Fluid Dynamics in the UK.* Report, University of Leeds, October 2021, https://doi.org/10.5518/100/77

**Speaker Biography**

Ann Dowling OM DBE FREng FRS is a Deputy Vice-Chancellor and Emeritus Professor of Mechanical Engineering at the University of Cambridge, where she was Head of the Department of Engineering 2009-14. Professor Dowling's research interests were on sustainable, low noise transport. She led the Silent Aircraft Initiative, a research collaboration between Cambridge and MIT, and ran the University Gas Turbine Partnership with Rolls-Royce 2001-14. She was a non-executive director of bp plc 2012-21 and is currently a non-executive director of the Smiths Group plc, where she chairs the science and sustainability committee. She was President of the Royal Academy of Engineering and a member of the Prime Minister's Council for Science and Technology 2014-19 and was appointed by the Queen to be one of the 24 members of the Order of Merit.

## Fluids Outreach and Engagement Talk

Staff and students from LIFD have been involved in a broad range of outreach activities from working with political leaders to splashing paint bubbles at MathsCity. Fluids lends itself to fun and serious engagement. In this talk we will highlight examples we've worked on and suggest opportunities for others to get involved.

## Katie Chicot, CEO, MathsWorld UK

**Speaker Biography**

Dr Katie Chicot, is the CEO of MathsWorldUK whose aim is to create the UK's first Mathematics Discovery Centre. Alongside this Katie is a Senior Lecturer, Staff tutor in Mathematics and Statistics at the Open University. This involves working with students,  tutors and creating materials. Both roles involve mathematics outreach including co-creating the series Patterns of life for the Open University's YouTube channel, captaining the OU's team on BBC2's Beat the Brain, participating in Facebook events, creation of a maths/brain teaser app called Perplex, and previously working as academic consultant to BBC Radio 4's More or Less.

## Ciara Higham, CDT Fluid Dynamics PhD student, University of Leeds

**Speaker Biography**

Ciara Higham is a PhD researcher at the Centre for Doctoral Training in Fluid Dynamics. Her work focuses on the potential risk of pathogen transmission associated with flushing the toilet. Ciara is passionate and actively involved in public engagement in STEM, particularly with groups who are underrepresented in the field. Her commitment to STEM outreach is evident through diverse contributions: developing engaging activities for various age groups with the UoL’s STEM outreach team, a Fluid Dynamics stall at Be Curious, volunteering with the grassroots organisation ScienceGrrl, and work as an enabler at MathsCity. Ciara has a strong interest in how scientific evidence can inform government policy and recently undertook an internship at the Government Office for Science.

Yatin Darbar, CDT Fluid Dynamics PhD student, University of Leeds

**Speaker Biography**

Yatin Darbar is currently pursuing a PhD at the Centre for Doctoral Training (CDT) in Fluid Dynamics at the University of Leeds. Before this, he earned a Master's degree in mathematics from the University of Birmingham. Yatin's research centers on elucidating the internal dynamics of coalescing droplets. Beyond his academic pursuits, Yatin actively engages in various outreach initiatives. He has crafted and conducted workshops for the University of Leeds outreach team, created engaging tweets for the LIFD, and successfully overseen both the KS3 Fluids Photo Competition and interactive stalls at the UoL’s Be Curious event.

## Dr Calum Skene, Research Fellow, University of Leeds

**Abstract Title**

'Adjoints and their uses in fluid mechanics'

**Abstract**

Adjoints are a mathematical technique that allow for gradient information with respect to a large number of parameters to be efficiently obtained. Applications of adjoints are wide, encompassing sensitivity analysis, optimisation, synchronisation, machine learning, and many other techniques. The fact that in fluid mechanics there are often many parameters which govern the underlying system has made adjoints a powerful tool for studying a variety of phenomena. Whilst they are more prominent in engineering based fluid mechanics, they have more recently started to be used in plasma physics, as well as in geophysical and astrophysical flows. In this talk I will give a brief overview of adjoints and showcase some of their uses for a range of fluid mechanics problems. Special attention will be given to ongoing work to add adjoint capabilities to the open-source equation solver Dedalus, as well the use of adjoints to find minimal seeds for subcritical phenomena in geophysical and astrophysical systems.

**Biography:**

Dr Skene obtained his PhD in Applied Mathematics from Imperial College London with the thesis 'Adjoint based analysis for swirling and reacting flows'. Following on from this he spent a year as a postdoc at UCLA before taking up his current position as a research fellow at the University of Leeds. Dr Skene's research combines applied mathematics techniques and scientific computation to study a range of fluid dynamics phenomena, from those motivated by engineering applications, to geophysical and astrophysical systems. As well as carrying out physically motivated studies, Dr Skene is also interested in the underlying methods and how they can be extended to new areas and made more efficient.

## Dr Thomas Sykes, Post Doctoral Research Associate, University of Oxford

**Abstract Title**

Droplet impact on liquid pools

**Abstract**

Droplet impact on liquid pools can be seen throughout industry and nature: rain-induced icing, spray cooling, raindrops hitting puddles, and agricultural sprays protecting crops – to name just a few examples. However, it is only in the last decade or so that the crucial role of a thin jet of fluid (ejecta sheet) during the first millisecond of impact on the subsequent dynamics has been appreciated. We will discuss some of our recent and ongoing work as part of a joint EPSRC-NSF project in this area, focusing in this talk on fast droplet impact that often leads to splashing.

Initially considering static pools, we will elucidate the effect of pool depth on impact outcomes using a combination of experiments and numerical simulations, including explaining why droplets impacting sufficiently shallow pools always produce a crown reminiscent of Edgerton's milk drop coronet. However, in many cases, droplets impinge on moving pools, transforming droplet impact into a fully 3D problem. Above a certain threshold, we show that pool movement has a dramatic effect on ejecta sheet dynamics in low viscosity conditions, resulting in different post-impact dynamics arising around the circumference of the droplet. We present a way to parameterise the impact outcome that accurately classifies the post-impact behaviour for a wide range of fluid properties and dynamic conditions, and naturally recovers the transition due to Reynolds number on static pools.

**Biography:**

Tom obtained his BSc degree in Mathematics at Leeds in 2016. He then joined the EPSRC Centre for Doctoral Training in Fluid Dynamics at Leeds, completing his PhD on droplet mixing in 2020. Tom is currently a Postdoc in the Fluid Dynamics Laboratory at the University of Oxford Department of Engineering Science, where he has worked on a variety of topics in droplet dynamics and other multiphase flows, funded by EPSRC, the John Fell Fund (as PI), and the Royal Society. Alongside this role, he is a Lecturer in Engineering at Wadham College, Oxford. Tom will be joining the University of Warwick this spring as an Assistant Professor (Fluid Mechanics) in the School of Engineering.

## Professor Cath Noakes, Professor of Environmental Engineering for Buildings, LIFD Co-Director, University of Leeds

**Abstract Title**

The fluid dynamics of infections - from science to policy

**Abstract**

Over the course of the pandemic we became acutely aware of the role that the environment plays in transmission of respiratory diseases, and how our interactions in indoor spaces determine the risk of infection. Understanding the routes of transmission is challenging, but modelling of aerosols, droplets and indoor airflows can play an important role in identifying mechanisms and determining mitigations. However, this mechanistic approach is only one part of a complex picture, and successful management of a respiratory disease is also significantly influenced by human behaviour, organisational strategy and policy choices.

Tackling the pandemic rapidly needed evidence to support national and international decisions, and the response pulled scientists worldwide into rapid research as well as supporting communication of evidence. In this talk I will give an insight into airborne disease and the importance of the physics of transmission in understanding practical mitigations such as ventilation controls. I will also reflect on the contribution of research into providing evidence to policy and public engagement during this period and how this influences the research we do going forward.

**Speaker Biography**

**Professor Cath Noakes, OBE, FREng, FIMechE, FIHEEM, FISIAQ, HonFCIBSE**

Cath is a chartered mechanical engineer, with a background in fluid dynamics. She leads research into ventilation, indoor air quality and infection control in the built environment using experimental and modelling-based studies. She is co-director of the EPSRC Centre for Doctoral Training in Fluid Dynamics and Deputy Director of the Leeds Institute for Fluid Dynamics. From April 2020-2022 she was a participant in the UK Scientific Advisory Group for Emergencies (SAGE) where she co-chaired the Environment and Modelling sub-focusing on the science underpinning environmental transmission of COVID-19. She has also contributed to numerous advisory and working groups including with WHO and the Royal Academy of Engineering. In 2023 she was awarded the Royal Society Gabor medal for her contribution to interdisciplinary science in understanding transmission of infection.

## Women in Fluids Discussion Panel

### Dr Carolanne Vouriot, Lecturer in Buidling Physics, University of Sheffield

Carolanne Vouriot received an MEng degree from the Department of Aeronautical Engineering at Imperial College London. She joined the Fluids Dynamics Across Scales Centre for Doctoral Training in Imperial College London, where she completed an MRes and a PhD in the Department of Civil and Environmental Engineering. Carolanne then worked as a research associate on the Schools' Air quality Monitoring for Health and Education (SAHME) project in the Department of Applied Mathematics and Theoretical Physics at the University of Cambridge. She joined the Department of Civil and Structural Engineering at the University of Sheffield as a Lecturer in Building Physics in 2023.Her research focuses on fluid dynamics for the built environment, specifically looking at the relationship between natural ventilation and indoor air quality, using numerical simulations and field measurements.

### Dr Claudia Castro Faccetti, Head of Research and Product Development, AirRated

Claudia Castro Faccetti is the Head of Research and Product Development at AirRated, a global indoor air quality certif ication company based in the United Kingdom. Previously, Claudia worked as a postdoctoral researcher at the University of Leeds and Imperial College London, and has been involved in EPSRC-funded projects HECOIRA and SAMHE, both in the field of indoor air quality. Her main professional focus is on studying and developing solutions in the intersection between engineering, environment, public health and education. She is the founder of a Women in Engineering Network in her native Colombia.

## Guneet Hawley, Senior Engineer, Arup

Guneet Hawley is a Senior Engineer at Arup, working for over 6 years in the field of fluid dynamics after graduating from the University of Leeds in 2017. Her role includes using Computational Fluid Dynamics (CFD) across a range of project applications such as pedestrian wind comfort, data centres, hydraulics and building physics. Guneet is also a specialist in the analysis of urban heat islands across cities, as well as the use of climate change projection data to ensure future resilience of designs.

## Dr. Talia Tokyay Sinha, Senior Hydraulic Engineer, Mott MacDonald

Dr. Talia Tokyay Sinha received her BSc degree on Civil Engineering from Middle East Technical University in Ankara, Turkey in 2003. Shortly after receiving her BSc, she started working as a graduate research assistant at Iowa Institute of Hydraulic Research (IIHR) Hydroscience and Engineering at the University of Iowa, Iowa City, USA. At IIHR, she began her career in Computational Fluid Dynamics (CFD). She received her MSc in Civil and Environmental Engineering from the University of Iowa in 2005. Her thesis was on large eddy simulation (LES) of flows in pump intakes. She worked on LES of gravity currents and their interaction with various substrates in her PhD research and received her degree in

2010 from the University of Iowa. She worked as a postdoctoral research associate at Ven Te Chow Hydrosystems Laboratory at the University of Illinois at Urbana-Champaign after completion of her PhD. In both institutions, additional to the fundamental research that she pursued, she had multiple opportunities to be involved in CFD projects funded by private and public stakeholders. Between 2015-2017, she worked as an Assistant Professor at Middle East Technical University, teaching undergraduate and graduate courses in the area of fluid dynamics and open channel hydraulics at the departments of Civil, Environmental and Petroleum Engineering. During this time, she supervised 4 Masters Thesis and secured a funding from National Science Foundation of Turkey (TUBITAK). Since 2020, she is working as a Senior Hydraulic Engineer at Mott Macdonald. To date, she has published more than 20 papers in highly regarded peer-reviewed journals (e.g., Journal of Fluid Mechanics, Journal of Physics, Journal of Hydraulic Engineering, Environmental Fluid Mechanics). She has over 15 years of experience in the area of computational fluid dynamics. She is married and mother of one.

## Professor Dame Jane Francis, Director of the British Antartic Survey and Chancellor of the University of Leeds

Professor Dame Jane Francis is the Director of British Antarctic Survey. In 2017 she was appointed Dame Commander of the Most Distinguished Order of Saint Michael and Saint George (DCMG) in recognition of services to UK polar science and diplomacy. She became Chancellor of the University of Leeds in 2018.

Jane Francis is a geologist by training, with research interests in past climate change. She has undertaken research projects at the universities of Southampton, London, Leeds and Adelaide, using fossils to determine the change from greenhouse to icehouse climates in the polar regions over the past 100 million years. She has undertaken over 15 scientific expeditions to the Arctic and Antarctica in search of fossil forests and information about climates of the past.

Jane was appointed Dame Commander of the Order of St Michael and St George (DCMG) in recognition of services to UK polar science and diplomacy. She was also awarded the UK Polar Medal by H.M The Queen, the Royal Geographical Society's Patrons Medal and the 2022 Prince Albert II of Monaco Foundation Award for Planetary Health. Jane is Chancellor of the University of Leeds and a Fellow of the Royal Society.

# Poster Abstracts

| **Name of lead author** | **Abdul Samad Rana** |
|---|---|
| Department/School of lead author | School of Chemical & Process Engineering |
| Name(s) of co-author(s) | Dr Tariq Mahmud; Professor Kevin J Roberts |
| Poster title | Modelling of Hydrodynamics of a Vortex Precipitation Reactor for Reprocessing of Spent Nuclear Fuel. |
| Poster theme | ❑ The Process Industry;<br>❑ Clean Energy; |

Abstract

Vortex precipitation reactors are used in the plutonium (Pu) finishing lines of the PUREX process to convert soluble Pu(IV)-nitrate into insoluble Pu(IV)-oxalate crystals via reactive precipitation. Pu(IV)-oxalate is converted into Pu-oxide downstream and mixed with uranium oxide to make MOX fuels. The configuration of a vortex reactor is an open tank with no baffles, which is agitated by a magnetic rod stirrer lying on the base of the tank where a central vortex is formed. Vortex formation is important as it circumvents particle adhesion to solid surfaces, minimising downtime for maintenance which can be critical in the nuclear industry. The hydrodynamic and mixing characteristics of such reactors have a significant effect on the precipitation process and its scale-up.

The objective of this work is to perform a CFD modeling study to characterise the hydrodynamics for two-phase air-water flow in a vortex precipitator used in the reprocessing of spent nuclear fuel. An Eulerian-Eulerian multiphase flow model coupled with a Volume-of-Fluid method for capturing the liquid free-surface vortex was used. The performance of different CFD codes (ANSYS FLUENT & OpenFOAM) was evaluated in addition to investigating different approaches to model the stirrer lying on the reactor base and different turbulence models. The quality of predictions was assessed against experimental data reported in the literature.

Once the hydrodynamic modelling approach has been established, deeper investigations into its influence on mixing and precipitation can be performed using CFD. This will be important to understand how reactor operation influences product quality and downstream processes.

| **Name of lead author** | **Ahmad Mohamadiyeh** |
|---|---|
| Department/School of lead author | School of computing |
| Name(s) of co-author(s) | Timothy Hunter, Mike fairweather, Jeff Peakall and Martyn Barnes |
| Poster title | Erosion of Sediment beds Using Impinging Jets: Application to Nuclear Waste Mixing |
| Poster theme | ❑ The Universe;<br>❑ Health;<br>❑ The Process Industry;<br>❑ Climate;<br>❑ Environment;<br>❑ Clean Energy;<br>❑ Fundamental Fluid Dynamics;<br>❑ Capacity and Knowledge in Fluid Dynamics |

Abstract

Impinging jets serve as a pivotal mechanism employed across various industrial applications; one of the relevant applications is the nuclear waste management industry. Within the facilities of Sellafield Ltd, impinging jets are used to erode and mix the nuclear waste in the highly active nuclear waste storage tanks (HASTs). It is important to erode the nuclear particles and keep them in suspension inside the tanks to avoid the creation of highly tenacious sediment beds and radioactive hotspots. There are several factors that affect the intricate nature of erosion phenomena which include the properties of the fluid, the properties of the jet, and the properties of the bed. The effect of bed properties such as bulk yield stress, particle size distribution, and cohesion on erosion is of interest given the wide range of nuclear particles available in the HASTs. One of the aims of the project is to experimentally investigate the role of bed properties, mainly cohesion, on erosion. Thus, an array of mixed cohesion-less and cohesive beds will be mimicked to investigate the effect of cohesion on jet erosion. Another aim is to perform high-fidelity numerical simulations to understand the hydrodynamics of impinging jet flow such as turbulence, recirculation, and their effects on erosion This would give us a better understanding of the flow patterns produced in the crater and the jet conditions/bed morphologies that initiates them. The poster includes a brief background and motivation behind the project as well as the aims of the project, methodology, results obtained from experiments, and future experimental and numerical work.

| **Name of lead author** | **Alexander J. Edwards** |
|---|---|
| Department/School of lead author | EPSRC Centre for Doctoral Training in Fluid Dynamics |
| Name(s) of co-author(s) | Prof. Catherine J. Noakes, Dr. Martín Lópéz-García, Dr. Marco-Felipe King, Prof. Daniel Peckham |
| Poster title | Assessing the Effects of Transient Weather Conditions on Airborne Transmission Risk in Naturally Ventilated Hospitals |
| Poster theme | Health |
| Abstract | |

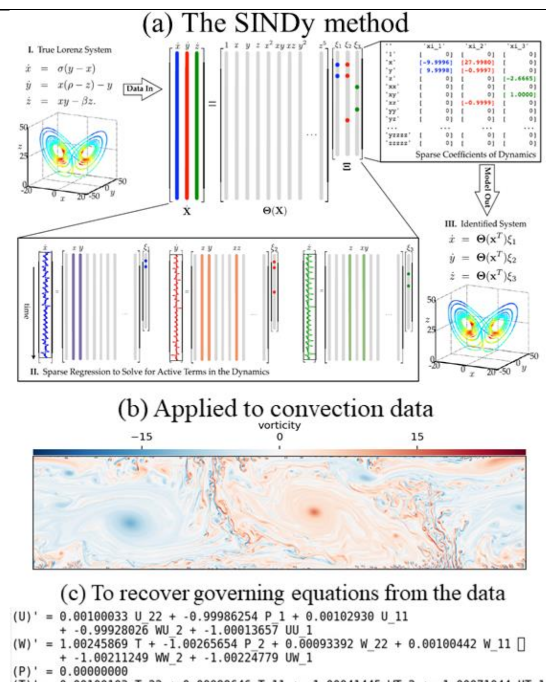
Weather conditions can influence ventilation and indoor airflow, so it is especially important to consider this in spaces that rely on natural ventilation, including many traditional UK hospitals. Using the modelling software CONTAM, we simulate airflow in a multi-zone naturally ventilated UK hospital respiratory ward, exploring transient weather conditions over different time scales to analyse the resulting airflow between connected indoor spaces. The simulated airflow is coupled with a previously developed airborne transmission model to assess the infection risk across the ward. Our results suggest that the use of natural ventilation with varying weather conditions can cause irregularities in the inter-zonal flow rates of connecting zones, leading to occasional unexpected peaks in the concentration of airborne pathogen in particular rooms, increasing the risk of infection. We found that particular weeks and zones have a higher risk of infection than others, and we see that this is better controlled when mechanical ventilation is implemented. From our simulations, we further demonstrate that the extract rates achieved by natural ventilation may fall far below the recommended rate of 6 ACH. Our model emphasises the need for consideration of transient external conditions when assessing the risk of transmission of airborne infection in indoor environments.

| Name of lead author | Dr Chris Wareing |
|---|---|
| Department/School of lead author | Maths |
| Name(s) of co-author(s) | Alasdair Roy, Prof. Steve Tobias |
| Poster title | Data-driven derivation of equations for the evolution of transport in turbulent flows |
| Poster theme | Fundamental Fluid Dynamics; |

Abstract

We present preliminary results of DNS of turbulent fluid dynamics coupled with machine learning techniques to derive new equations for the evolution of transport in turbulent flows. We examine Rayleigh-Benard convective turbulence with the aim to learn the statistics of unresolved scales for turbulent parameterization. Following the approach of Garaud et al. 2010 [MNRAS 407 2451-2467] in order to perform a comparison to their result, we seek a closure model for the transport of entropy and momentum intended for application to rotating stellar convective regions. We use the Dedalus framework for spectrally solving differential equations to generate an extended time-series of two-dimensional DNS data at a Rayleigh number of 1e10. We then use 1) the data-driven Sparse Identification of Nonlinear Dynamics (SINDy) algorithm and 2) the Sparse Physics-Informed Discovery of Empirical Relations (SPIDER) method to discover the form of the governing equations and then investigate the triple correlation terms, paying particular attention to capturing any difference between the bulk and boundary layers. Finally, we discuss possible avenues for future work, including applying the same machine learning methods to convective rotating turbulence, with mean flows and magnetic fields, as well as the application of Bayesian machine learning methods to this work.

Image



| **Name of lead author** | **Ciara Higham** |
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| Department/School of lead author | EPSRC Centre for Doctoral Training in Fluid Dynamics, University of Leeds, UK |
| Name(s) of co-author(s) | Martín López-García, Catherine Noakes, Louise Fletcher<br><br>School of Mathematics, University of Leeds, UK.<br>School of Civil Engineering, University of Leeds, UK. |
| Poster title | Exploring the toilet plume: experimental insights into environmental contamination using a mechanically ventilated chamber |
| Poster theme | Health |

Abstract (200 words)

Shared toilets are a likely facilitator of disease transmission including faecal-oral pathogens and potentially respiratory viruses. There is a need to reduce the risk of transmission in such an essential and highly frequented environment. The act of flushing a toilet generates droplets and aerosols, referred to as the toilet plume. These droplets are capable of entraining microorganisms as large as bacteria and can remain viable for extended periods, migrating well away from the toilet.

The objective of this work is to analyse size distributions of droplets and bioaerosols generated during a toilet flush in a controlled environment, mimicking a two-cubicle shared bathroom. The work seeks to address gaps in previous research by relating particle counts and bioaerosols and using this data to quantify infection risk.

Particle counts and bioaerosol measurements were taken. Particle counts were found to decay to background levels at a slower rate in the cubicle scenario, in some cases taking 10 minutes. The smaller sized particles (less than 1 µm) had an increase in absolute terms compared to the larger sizes (1-10 µm). The work is relevant to shared restrooms, such as workplaces or hospitals.

| **Name of lead author** | **Curtis J. Saxton** |
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| Department/School of lead author | Department of Applied Mathematics |
| Name(s) of co-author(s) | Curtis J. Saxton; Ajay Chandrarajan Jayalekshmi; Anna Guseva; Ben F. McMillan; Steven M. Tobias |
| Poster title | Entropy, complexity, and causality in direct and approximated fluid simulations |
| Poster theme | ❑ Fundamental Fluid Dynamics; |
| Abstract | |

Information entropy measures the disorder or inherent difficulty of predicting spatial and temporal structures in a time-series or spatially in a high-dimensional dynamical system. Statistical complexity characterises departures from equilibrium distributions (even given a fixed entropy), and can distinguish deterministic from stochastic physics (chaos vs noise). Related measures of causality quantify the relative influence of time-irreversible and -reversible processes (or directionality spatially). Calculating these scores from direct numerical simulations can characterise the importance of coherent structures or turbulent transitions. It is also interesting to compare the scores for physically equivalent models calculated via approximate methods (e.g. generalised quasilinear models or data-driven codes). The entropic cost of any approximation scheme is objectively derivable. We consider diverse applications to (e.g.) fluid thermal convection, magneto-rotational turbulence, and gyrokinetic plasma turbulence.

| **Name of lead author** | **Francis Dent** |
|---|---|
| Department/School of lead author | Sepideh Khodaparast |

| Poster title | Biomimetic patterning using droplets for enhanced surface functionality |
|---|---|

**Abstract**

Intricate patterns and micro-textures found on biological surfaces provide evolutionary-optimised inspirations for the design of functional materials. Micro/nanopatterns engender enhanced wetting, self-cleaning and antibacterial functionalities, leading to novel innovative applications in emerging technologies. The realisation of desired properties can be emulated through biomimetic design approaches, in which we draw inspiration from the self-assembled designs and energy-efficient fabrication mechanisms manifested in natural systems. Here, we explore fluid-based fabrication through an adapted breath figure (BF) templating methodology for low-cost manufacture to overcome inherent cost and scalability limitations associated with the conventional microfabrication techniques. To this end, we employ the spontaneous nucleation and self-assembly of condensation water droplets to dynamically pattern polymer films. Through in-situ real-time interrogation of the condensation and system physics, we attain programmable pore sizes ranging from hundreds of nanometres to tens of micrometres. Further, we exploit the inherent phase-change reversibility in the driving surface patterning mechanism, modulating the final surface architecture through regimes of condensation and evaporation. Enabled by our new patterning approach, surfaces with spatially and hierarchically diverse designs are manufactured, and tested against their natural analogues.

**Image**

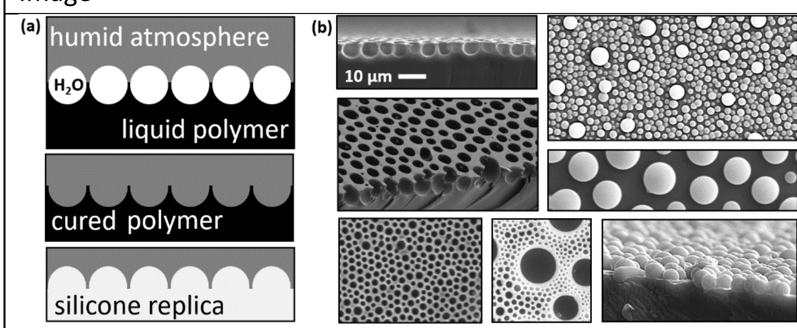


Figure 1. Temporally arrested BF allows deterministic patterning of porous polymer films and fabrication of complex protruding features through replication (a). Examples of micropatterns showing the versatility of the approach (b).



| **Name of lead author** | **Gregory Dritschel** |
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| Department/School of lead author | Applied Mathematics |
| Name(s) of co-author(s) | Steven Tobias, Douglas Parker and Lorenzo Tomassini |

| Poster title | A Mathematical Analysis of an Idealised Climate Change Scenario |
|---|---|
| Poster theme | Climate<br>Fundamental Fluid Dynamics; |
| Abstract | |

The Rainy-Benard model can be viewed as the moist extension of the Rayleigh-Benard model of dry convection. Including moisture changes the character of the convection, with condensation providing a source of buoyancy. In this poster, we develop and analyse an idealised climate change scenario for the Rainy-Benard model, and establish a theoretical framework for using the model to study climate change. This framework is constructed by first finding the analytical form of the model's basic state across the climate parameter space. We study basic states with positive convective available potential energy, a necessary condition for instability. We use a linear stability analysis to determine the critical Rayleigh number for the onset of convection. The results provide a basis for future work involving the non-linear evolution of these instabilities, as well as their implications for rainfall as a function of climate change parameters.



| **Name of lead author** | **Jo Kershaw** |
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| Department/School of lead author | CDT Fluid Dynamics, School of Computing |
| Name(s) of co-author(s) | C J Davies, J E Mound, S M Tobias |

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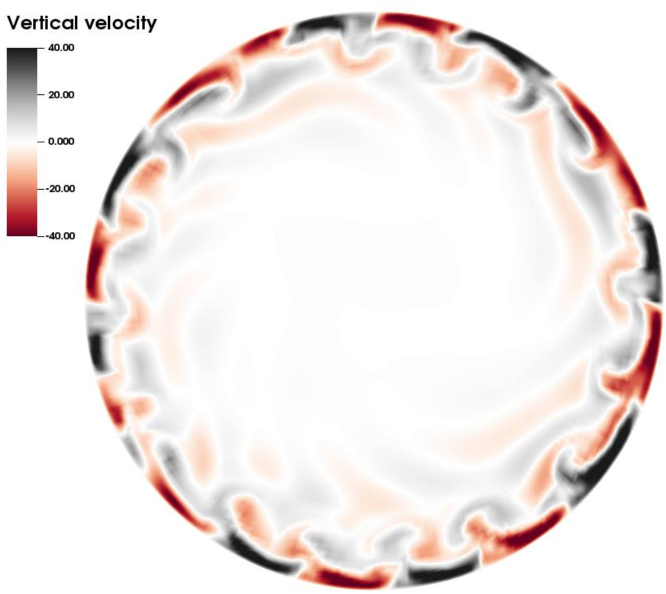
|---|---|
| Poster title | Rotating Convection Dynamics in Earth's Outer Core |
| Poster theme | The Universe; |

Abstract

An understanding of the flow dynamics of liquid metal in Earth's outer core is a first step to unraveling the mechanisms behind the generation of our planet's magnetic field. Simplifying assumptions are necessary to numerically model extreme temperatures and pressures while accounting for complex non-linear dynamics and a huge range of temporal and spatial scales. This project focuses on investigating the dynamics of non-magnetic rotating convection in different regions of the spherical shell geometry. Bridging the gap between spherical shell simulations and more computationally efficient cylindrical models should allow a more comprehensive exploration of the parameter space. We use temperature and velocity data from existing simulations conducted in a spherical shell and interpolate them onto cylindrical grids. The initial aim is to replicate the dynamics within the polar zone using the conditions at the boundaries of the tangent cylinder. In the first stage, simulations will be performed using Nek5000 in a cylindrical domain. The conclusions of this study will have implications for our understanding of rotating systems in curvilinear geometries and will contribute to our understanding of magnetic field generation in diverse astrophysical and engineered systems.

Image (optional, one image only)





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| **Name of lead author** | **Kasia Nowakowska** |
| Department/School of lead author | School of Computing |
| Name(s) of co-author(s) | Douglas Parker, Steven Tobias, Lorenzo Tomassini |

| Poster title | Nowcasting using a Simplified Model for Moist Convection |
|---|---|
| Poster theme | Climate |


| Abstract |
|---|
| Nowcasting describes the current state of the weather and provides forecasts for the next few hours, typically within the 0-6 hour time range. Prediction of convective storms within this timeframe is challenging, and while traditional nowcasting methods track the movement of convective cells effectively, predicting the initiation and decay of cells has proven more difficult. In this study, we explore the fundamentals of short-term prediction by employing a simplified model for moist convection known as the Rainy-Bénard model, which extends the classical Rayleigh-Bénard convection. Our main objective is to investigate secondary convective initiation driven by gravity waves. We will focus our analysis on exploring the underlying processes that trigger plume initiation and determining the specific locations and patterns where these plumes form. Initial results indicate that plume initiation in the model is associated with gravity wave convergence, low convective inhibition, high potential energy for convective behaviour, and high kinetic energy. To predict the initiation of these plumes, we intend to use a specific type of machine learning known as Echo State Networks. By employing this technique, we aim to deepen our understanding of gravity wave initiation and enhance our ability to make accurate predictions, with the potential to inform real-world nowcasting tools. |



| **Name of lead author** | **Laura Cope** |
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|---|---|
| Name(s) of co-author(s) | S. M. Tobias and J. B. Marston |
| Poster title | Magnetised turbulent-laminar dynamics in shear flows |

Abstract

Turbulence is ubiquitous in nature, however, the characterisation of the transition that gives rise to turbulence in shear flows is yet to be accomplished. Intermittency is a defining feature of the initial onset of turbulence in wall-bounded flows, in which chaotic regions, often in the form of bands or spots, coexist and compete with laminar motion. In this study, we attempt to unfold this laminar-turbulence transition by adding a magnetic field to the problem, the presence of which suppresses the excitability of the medium, making the turbulence less intermittent and modifying the form of the bands. By considering the low magnetic Reynolds number approximation, we introduce a second control parameter, the Hartmann number, thereby enabling this transition to be explored in a systematic manner. Specifically, we study the idealised shear between stress-free boundaries driven by a sinusoidal body force. This system, known as Waleffe flow, is further reduced by constructing a model that uses only four Fourier modes in the wall-normal direction, thus substantially reducing the computational cost of simulations whilst retaining the fidelity of the essential physics. Conclusions are drawn based on a series of carefully designed numerical simulations.

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| **Name of lead author** | **Miranda J S Horne** |
| Department/School of lead author | School of Computing |
| Name(s) of co-author(s) | Professor Peter Jimack, Dr He Wang, Dr Amirul Khan |

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|---|---|
| Poster title | Hard Constraint Projection in a Physics Informed Neural Network |
| Poster theme | Capacity and Knowledge in Fluid Dynamics |

Abstract

Machine learning provides a promising framework to simulate fluid dynamics at a fraction of the computational cost of traditional numerical methods, and the incorporation of domain knowledge into a neural network can improve prediction accuracy, increase explainability, and reduce the reliance on training data. Typically, the incorporation of the physical constraints into a neural network is only weakly enforced, for example in the form of a penalty term in the loss equation. In the cases where a physical constraint is strongly imposed, the enforced governing equation has been either linear or weakly nonlinear, or the hard constraint is for an additional conservation law (such as the incompressibility constraint).  Here, techniques from linear algebra are used to project the initial network predictions to a hyperplane that contains only exact solutions to the discretised governing PDE, following the work done by Chen et al. in 2021 [1]. The viability of this technique is assessed on a two-dimensional vortex shedding test case, governed by the strongly non-linear Navier-Stokes PDE.

[1] Y. Chen, D. Huang, D. Zhang, J. Zeng, N. Wang, H. Zhang, and J. Yan, “Theory-guided hard constraint projection (HCP): A knowledge-based data-driven scientific machine learning method,” JCP, vol. 445, p. 110624, 2021



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| Department/School of lead author | CDT Fluids |

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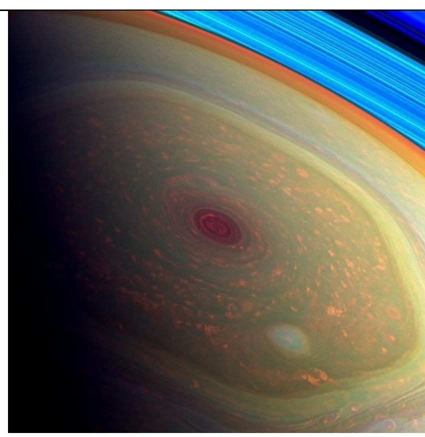
|---|---|
| Name(s) of co-author(s) | Evy Kersalé, David Hughes, Chris Davies and Fryderyk Wilczynski |
| Poster title | The Formation of Large-Scale Vortices on Jupiter and Saturn |
| Poster theme | ❑ The Universe;<br>❑ Fundamental Fluid Dynamics; |

Abstract

Within the wide array of atmospheric circulation patterns seen across the solar system, polar vortices are an almost universally observed planetary-scale phenomenon. Recent missions to Jupiter and Saturn have offered satellite images of their polar regions with unparalleled detail. These images have unveiled unexpected structures. At Jupiter's Northern pole, there exists a cluster of vortices, with a central vortex at its core, surrounded by eight vortices of similar size. A similar arrangement is present at Jupiter's Southern pole, featuring six surrounding vortices. In contrast, both polar areas of Saturn display a sizable central vortex encircled by numerous smaller vortices. Notably, Saturn's Northern hemisphere boasts a unique feature: a zonal "hexagonal" westerly jet encompassing the vortex.

These captivating observations raise numerous questions about their origins. One conceivable hypothesis proposes that these vortex formations stem from the rotational convection within the layered outer zones of the planets, where properties like viscosity and density undergo substantial changes with planetary radius. The aim of this research is to attain a thorough comprehension of the instabilities arising from rotating stratified convection, with a particular emphasis on a simplified model of two-layer convection in rotation.

Image



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| **Name of lead author** | **Steven Boeing** |

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| Department/School of lead author | School of Earth and Environment |
| Name(s) of co-author(s) | Matthias Frey (University of St Andews), David Dritschel (University of St Andews) |
| Poster title | Mixing formulations for parcel-based simulations of cumulus clouds |
| Poster theme | ❑ **Climate;** |

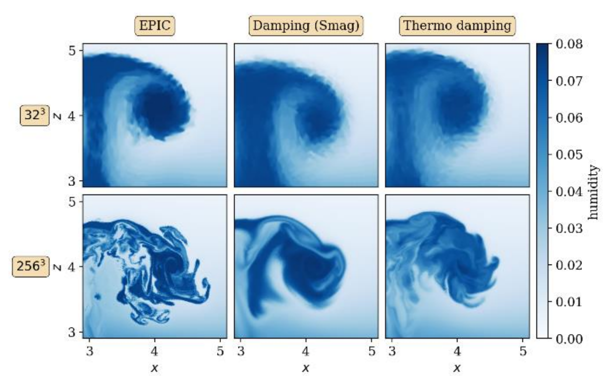
Abstract (200 words)


The Elliptical Parcel-In-Cell (EPIC) model provides a novel approach to geophysical fluid dynamics, based entirely around Lagrangian parcels. The parcels in EPIC represent both the thermodynamic and the dynamical prognostic properties of the flow. An efficient grid-based solver calculates parcel advection velocities. Diffusive regridding operations are avoided in this approach.

The Lagrangian nature of EPIC has a number of advantages that are particularly relevant to moist atmospheric convection: thermodynamic/tracer properties and their correlations are naturally conserved, and the amount of mixing between parcels is explicitly controlled. The formulation of this explicit mixing plays a key role in regions of high liquid water content, where precipitation forms. We study these regions of high liquid water content in more detail using simulations with different resolutions.

We also demonstrate the first use of EPIC to simulate an ensemble of shallow cumulus clouds, with an emphasis on the development of cloud size and spacing, vertical structure of clouds, mixing and vorticity dynamics during the simulation. We demonstrate that the formulation of small-scale mixing plays a key role in determining the liquid water path and the intensity of the cumulus convection.


Image




| **Name of lead author** | **Tushar Srivastava** |
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| Department/School of lead author | School of Chemical and Process Engineering |
| Name(s) of co-author(s) | Andrew Bayly |

| Poster title | Droplet-particle collisions: capture or separation? |
|---|---|
| Poster theme | Fundamental Fluid Dynamics; |

Abstract

Droplet-particle (D-P) collision is a ubiquitous phenomenon contributing to particle capture/ agglomeration in applications like spray drying, fluid bed cracking, and aerosol scavenging. The literature exploring the collision dynamics of moving D-P system is less and inhibited by the relative difficulty in conducting experiments with small-sized droplets and particles.

We report experiments to study the collision dynamics of a moving D-P system. An in-house experimental setup was used which consists of a droplet dispensing system, particle feeder, and two high-speed cameras. During experiments, mono-sized water droplets of 400-micron diameter were dispensed and made to collide with spherical glass beads of 150-micron diameter released from the particle feeder. The droplet speed and the collision angle were changed to vary the Weber number. The two high-speed cameras captured the front and side view images of the D-P collision which were further processed to determine the offset between the droplet and the particle just before collision.

Results revealed that at low Weber number, the D-P collision always resulted in particle capture irrespective of the offset. However, at high Weber number, the tendency of the particle to separate from the droplet after collision enhanced with increase in offset.



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| Name(s) of co-author(s) | Johnathan E. Mound, Christopher J. Davies, Andrew Clarke |

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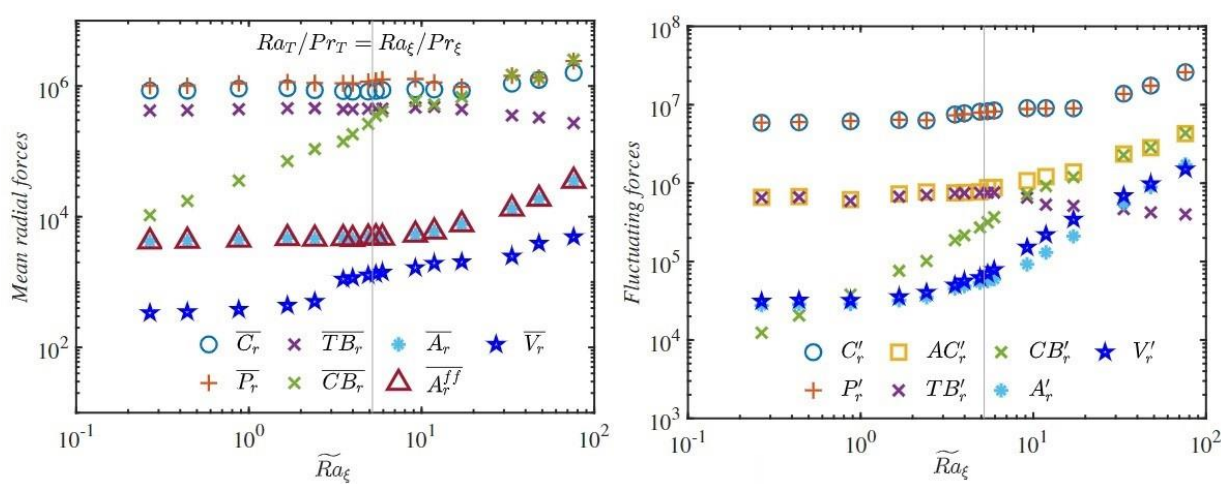
|---|---|
| Poster title | Force balance in double-diffusive rotating convection in a spherical shell |
| Poster theme | ❑ **Fundamental Fluid Dynamics;** |

Abstract

The geomagnetic field is sustained by thermochemical convection in Earth's outer core. Crystallization of the solid inner core releases latent heat and light elements, providing both thermal and chemical buoyancy sources. Most geodynamo simulations use the codensity approach, ignoring the vastly different diffusivities and different boundary conditions for the thermal and chemical fields and thus cannot capture double-diffusive effects. In this study, we consider a numerical convection model of a Boussinesq mixture of light elements in a heavy fluid confined within a rotating spherical shell. The governing parameters are the Ekman number [Equation], a non-dimensional measure of the rotation rate, the thermal and chemical flux Rayleigh numbers (RaT=9×106−1.2×108 *9×106−1.2×108* and Raξ=3×106−1010), representing the non-dimensional thermal and chemical forcing, and the thermal and chemical Prandtl numbers (PrT=1 and Prξ=10), that are fluid properties. We have performed a detailed analysis of the force balance that emerges within these simulations. We find a transition from a thermal wind to a chemical wind balance with increasing chemical forcing in the azimuthally averaged "mean" forces in the radial direction. The transition is found to occur at buoyancy ratio, [Equation]. However, the corresponding "fluctuating" balance is quasi-geostrophic in all directions. The analysis enables us to locate the geophysically relevant "rapidly rotating" regime in this parameter space.

Image




Caption: Balance of azimuthally averaged mean (left panel) and fluctuating (right panel) radial forces in top-heavy double-diffusive rotating convection at $Ra_T=9\times10^6$, $E=2\times10^{-5}$, $Pr_T=1$ and $Pr_\xi=10$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| **Name of lead author** | **Yatin Darbar** |
| Department/School of lead author | CDT for Fluids Dynamics |
| Name(s) of co-author(s) | Mark Wilson, Thomas Sykes, David Harbottle, Harvey Thompson |

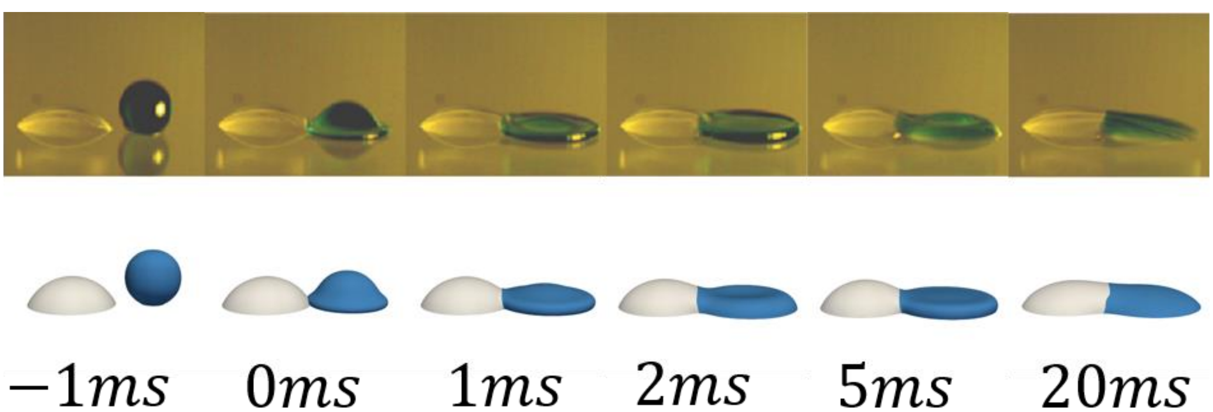
| Poster title | Mixing dynamics of inkjet printed droplets |
|---|---|
| Poster theme | ❑ The Process Industry;<br>❑ Fundamental Fluid Dynamics; |

Abstract

Numerous manufacture and fabrication processes such as Reactive Inkjet Printing rely on the adequate mixing of printed droplets. Understanding the mixing dynamics of these droplets helps to optimize industrial processes. To elucidate the mixing process a numerical simulation method using the Volume of Fluid Method in the open source software OpenFOAM is proposed to capture the dynamic mixing of impacting and coalescing droplets in realistic inkjet printing conditions. The approach involves coupling a diffusive transport equation for a conserved scalar with a hydrodynamic model for droplet coalescence, enabling the full simulation of the mixing process.

Validation of our simulations is achieved through analytic theory and comparison to published millimetric experimental data. The study provides insights into the time required for inkjet droplets (approximately 50µm) to mix effectively. Results show the amount of mixing we expect on the timescale of coalescence for a range of important parameters to the system. Enhanced mixing is observed when maximizing the internal interface between droplets, offering a potential avenue to exert control over the droplet mixing process.

Image

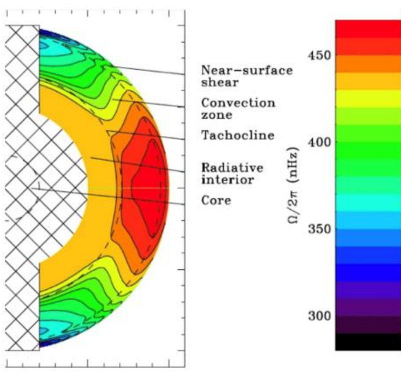



| **Name of lead author** | **Samuel Myers** |
|---|---|
| Department/School of lead author | School of Mathematics |
| Name(s) of co-author(s) | Steven Tobias and Stephen Griffiths |
| Poster title | Investigating a magnetoshear instability |

| | |
|---|---|
| Poster theme | - The Universe;<br>- Fundamental Fluid Dynamics; |

Abstract (200 words)

Motivated by understanding the solar tachocline, we use a combination of numerical and asymptotic techniques to investigate the linear stability of a uniform velocity shear with a smooth spike of magnetic field. We consider the simple case where the field is aligned with the shear and discover a new instability that is triggered by the presence of strong currents and flow. The asymptotic analysis of this is complicated involving an inner, outer and two intermediate matching layers.




Sam Myers (died 28th December 2023)